

# Laparoscopic Surgery in Pediatric Age Group – Our 10 Years Experience from a Tertiary Care Centre

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## ABSTRACT

**Background:** To study the role of Laparoscopic surgery in Pediatric age group. Settings: Department of General and Minimal Access Surgery, Government Medical College Srinagar. **Methods:** Three hundred and sixty four pediatric patients referred to our tertiary care center in the pediatric age group were operated upon laparoscopically for various conditions from January 2009 to January 2019. **Results:** A total of 364 non-infantile pediatric cases were operated upon laparoscopically which included 107 Non-palpable UDT, 71 Appendectomies, 67 Diagnostic laparoscopies, 31 Cholecystectomies, 5 VATS procedures, 8 Varicocelectomies, 2 Advance urological procedures, 55 Herniotomies, 3 umbilical hernia laparoscopic anatomical repairs, 7 Hepatic Hydatid cyst surgeries, 5 Laparoscopic assisted Soaves procedures, 1 each of Laparoscopic Pyeloplasty, Morgagni hernia repair and Ladd's procedure for Malrotation of Gut. There were 5 conversions to open procedure and 8 cases were completed by laparoscopic assisted methods. The complication rate including minor complications was approximately 4%. **Conclusion:** Laparoscopy including Video-assisted Thoracoscopic Surgeries (VATS) in pediatric age group is safe, feasible and rapidly gaining popularity even for advanced and reconstructive procedures. However the threshold for better judgement should be low for decreasing avoidable morbidity in small children.

**Keywords:** Laparoscopy, Pediatric, VATS, Experience.

## INTRODUCTION

Laparoscopy has revolutionized medical field pertaining to not only the management of surgically correctable conditions affecting paediatric age group but also the minds of the surgeons practising it as evident by its widespread acceptability and reproducibility around the globe. With initial learning curve reaching plateau in the current times, many institutes have come up with enormous data as reflected in many recently published studies showing encouraging results of laparoscopy in the paediatric age group as was seen earlier with adult population few decades back.<sup>[1,2]</sup> We present our experience of performing laparoscopic surgeries in Paediatric age group over the last 10 years stressing upon few commonly performed procedures and also reviewed relevant literature.

## MATERIALS AND METHODS

Three hundred and sixty four pediatric patients in pediatric age group were operated laparoscopically for various conditions from January 2009 to January 2019 referred to Department of General and Minimal Access Surgery, Government Medical College, Srinagar a teaching tertiary care center from various parts of Kashmir. The parents/Guardians of all referred patients were counseled after elaborate history taking; thorough examination and after conducting relevant investigations for making final diagnosis. The options of Laparoscopic surgical interventions including diagnostic laparoscopy were discussed. Written informed consent was taken from Parents/Guardian.

The First port placement for telescope in laparoscopy was consistent at supra-umbilical region, initially using open Hassan's technique but later on with experience switched over to insertion of Pediatric Veress needle for creating pneumo-peritoneum. The pneumo-peritoneum was achieved by using carbon-dioxide and pressure was maintained at 6-12 mm of Hg depending on age and

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weight of the child. In cases of VATS the first port was placed through tube thoracostomy if present or at the mid-axillary level from 5th – 7th intercostal space. Second, third and fourth port if required for both laparoscopy and VATS were placed directly under vision as per the merits of the condition and body habitus taking care to maintain ergonomically feasible triangularity. A 5 mm 00 or 300 telescope was used in majority of the cases and 10 mm 300 telescope was used in few cases in older children or sometimes when the procedure involved removal of a large specimen. A thorough abdominal surfing was the first thing performed after creation of pneumoperitoneum. A thorough search for the pre-operatively diagnosed pathology as well as for any other additional pathology was done.

## RESULTS

There were 364 pediatric patients in the pediatric age group operated laparoscopically for various conditions. [Table 1]

### Hepatobiliary System:

**Laparoscopic Cholecystectomy [Figure 1]:** We performed this procedure in 31 patients. All were symptomatic cholelithiasis confirmed by USG. Age ranged between as young as 2 ½ years to 14 years. Three patients had haemolytic disease. There were 9 males and 22 female patients. Conventional 4 port Cholecystectomy was done. Two patients had difficult Calot's dissection apparently acute attack but were managed laparoscopically by meticulous dissection and required abdominal drain for 1-2 days. Operating time ranged between 30-90 minutes with mean of 45 minutes. None of the cases required conversion. Specimen retrieval was done via 10 mm epigastric port in older children. Majority cases were discharged next day afternoon once tolerated orals which were started 24 hrs post-operatively. Patients were followed after 1 week post operatively. We had 1 port site superficial infection managed conservatively with local management and antibiotics.

**Laparoscopic Hepatic Hydatid Cystectomy [Figure 2]:** We encountered seven such children with hepatic Hydatid disease. Pain and swelling right upper quadrant was the commonest presentation. Ultrasound (US) was the initial radiological investigation and patients were subjected to CECT Abdomen for further details of the lesion. Size ranged between 5 cm -14 cm. Serology confirmed the diagnosis in all but 1 case with infected lesion. We managed 7 cases laparoscopically, 3 boys and 4 girls ranged between 3 -14 years of age. There were total 10 lesions as 1 girl had 2 lesions and 1 boy had 3 lesions including one abutting the GB fossa. We required 3 ports (Umbilical port for telescope 5mm/10mm depending on the age, 5 mm epigastric

port and a 3mm/5mm right lateral port few centimetres below right subcostal margin in the anterior axillary line) All precautions were taken as done in open procedures. 10% povidone-iodine was used as scolicidal agent. Disposable cover of drip set was used as specimen retrieval bag. Two abdominal drains 1 in cavity and another in Morrison's were kept post operatively. Morrison's was removed in a day or 2 but cavity drain was kept for 4-5 days except 2 cases. In one case drain was removed after 2 weeks and in another case there was prolonged biliary drainage required planning for ERCP and stenting but unfortunately ERCP failed twice for stenting and patient was observed for 12 weeks and finally cavity drain was removed after 12 weeks once the biliary drainage stopped. The same patient developed hyponatremia during the course of treatment which was corrected. Serial follow up US were done 3 monthly for 1st year post operatively and 6 monthly thereafter. One peculiar thing we noticed in all the cases barring one there was always some residual cavity which gradually decreased in volume over years.

### Abdominal wall and Diaphragm

**Congenital hydrocele/Hernia [Figure 3]:** A total of 68 Laparoscopic Herniotomies was performed on 55 patients. There were 38 boys and 17 girls. Seven boys and 6 girls had bilateral patent deep inguinal ring. Only 2 patients had preoperatively diagnosed bilateral hernias. We used 5 mm supra-umbilical port for telescope and two lateral 3 mm working ports on either side one at the level of the umbilicus and another midway between umbilicus and symphysis pubis along linea semilunaris depending on the side affected. In case of bilateral both lateral working ports were mirror image on either side of umbilicus. In all cases opposite DIR was assessed for patency. The contents if present (mostly omentum) were reduced by gentle traction. All were reduced except 1 case which required excision using energy source. The peritoneum around DIR was incised starting from 3 o'clock on the right side and 9 o'clock on the left side. Utmost care was taken to avoid injury to Vas and vessels. 3-0 Vicryl was used to close the peritoneal defect. The suture while passing through peritoneum from 9 o'clock to 6 o'clock on right side and 6 o'clock to 3 o'clock on the left side also incorporated little bit of musculature around DIR thus avoiding Vas and Vessels in the suture. The suturing and knotting was accomplished either intracorporeally or by passing suture through anterior abdominal wall just infomedial to anterior superior iliac spine after making a skin subcutaneous incision tying the knot subcutaneously. Operating timing was between 30 minutes to 100 minutes with a mean of 45 minutes. Patients were followed after 1 week, 3 months and yearly thereafter. There were 3 recurrences managed by open procedure. Three boys had scrotal oedema

necessitating antibiotics post operatively for few days. One child had an abdominal component of hydrocele sac. [Figure 4]

**Umbilical Hernia Laparoscopic anatomical repair:** Three girls aged between 4 years – 7 years diagnosed with umbilical hernia defect sized between 2-3 centimetres underwent Laparoscopic anatomical repair. We used 2-0 prolene suture passed through anterior abdominal wall after making incisions through skin and subcutaneous tissue. The procedure was done under laparoscopic guidance and knots were tied subcutaneously once the suture was passed again through anterior abdominal wall crossing the defect intra-peritoneal. All defects required 3-4 sutures for closure. Operating time was between 50 – 90 minutes. The patients were discharged next day post operatively once orals were tolerated. Follow up was done at 1 week and 3 months.

**Morgagni Hernia:** Laparoscopic Morgagni hernia repair was done in a 12 years old boy who presented with dyspnoea. Chest X-ray showed distended gut above the right dome of diaphragm. CECT revealed transverse colon inside the right thoracic cavity. 3 Ports including 10 mm umbilical for telescope and 2 lateral 5 mm working ports on either side were placed. Large 7 centimetres defect was identified antero-medially in the diaphragm. Contents were reduced. Vicryl 1-0 was used as interrupted sutures to close the defect. Child was discharged on 6th post operative day.

### Gastro-Intestinal System

**Appendicitis:** Seventy one patients including 30 boys and 41 girls in the age group of 3 years to 14 years underwent Laparoscopic Appendectomy. All were elective cases. Three ports were used. One 5 mm/10 mm umbilical port for telescope, two 3 mm/5 mm lateral ports, one in the midline between umbilicus and pubic symphysis and another at the level of umbilicus on the right side were placed. The size of the port was determined by the age and weight. Appendectomy was performed using intracorporeal knotting/endoloop/ 5 mm harmonic shears. Specimen was retrieved using finger glove through 5 mm/10 mm umbilical port. Operating time was between 45-110 minutes (Mean 65 min). Abdominal drain was kept for a day for haemostasis in cases where local adhesions were present but majority of the patient did not require a drain. We had to convert 2 cases where extensive intra-abdominal adhesions were present. 1 patient had port site infection managed with antibiotics and another case had a sub-phrenic collection requiring pig-tail drainage achieved sonologically.

**Hirschsprung's Disease:** Five cases of classical Hirschsprung's disease underwent Laparoscopic assisted Soave's procedure. Age ranged between 5-12 years. There were 2 males and 3 female patients. Operating time ranged between 90-120 minutes. All

patients had covering colostomy post operatively. There was 1 case of post operative Enterocolitis managed conservatively.

**Malrotation of Gut:** One boy aged 14 years presented with recurrent sub-acute intestinal obstructions and was diagnosed as Malrotation of gut on Colour Doppler and CECT abdomen. Child underwent Laparoscopic assisted Ladd's procedure. Majority of the procedure including excision of Ladd's bands, appendectomy, partially widening of mesentery. A small 4 cm midline supra-umbilical incision was made to complete the other steps of procedure like complete widening of mesentery and placement of large gut on the left side, small gut on the right side.

### Genito-Urinary System

#### **Non-Palpable Undescended Testis (NPUdT)**

**[Figure 5]:** A total 107 boys aged 1 year to 13 years underwent Laparoscopic surgery for NPUdT. After thorough parental counselling and evaluation (serum markers, US, MRI), 105 Orchidopexies (including 3 by Fowler-Stephen) and 2 Orchidectomies were performed. Operating time ranged from 60 – 90 minutes (mean 80 minutes). Two boys had testicular atrophy and 3 had high up ascended testis on follow up. Three ports were used for access. Lengthening was achieved by careful dissection avoiding injury to Vas and vessels. Appropriateness of length was accessed by making testis move freely towards opposite internal ring. Majority of the testis were brought out into the sub-dartos pouch by creating a tunnel through anterior abdominal wall medial to the inferior epigastric vessels. Some were passed through the patent deep inguinal ring (DIR) into the created sub-dartos pouch and deep inguinal ring was closed by using 3-0 Vicryl. Two cases of Stephen-Fowler had their second stage procedure done by inguinal approach as the testis was anchored at DIR during 1st stage and one was managed laparoscopically in both stages.

**Varicocelelectomy:** Eight boys age ranged between 4 years to 12 years with clinico-radiological diagnosed cases of varicocele were operated upon by Laparoscopic Varicocelelectomy. Operating time ranged between 25 – 50 minutes (Mean 35 minutes). Port placement was same as that for Herniotomy.

**Congenital Pelvi-Ureteric Obstruction (PUJO):** A girl aged 3 years with history of recurrent urinary tract infections was evaluated with Urine routine examination, urine culture sensitivity, US abdomen, DTPA scan which revealed PUJO. She underwent Laparoscopic assisted Anderson-Hynes dismembered Pyeloplasty by trans-peritoneal approach. Three Ports were used which included one 5 mm umbilical for telescope and 2 lateral working 3 mm ports. A 6 Fr DJ stent was placed after just before completing anastomosis during Anderson-Hynes pyeloplasty. The procedure took 110 minutes and patient was discharged on 5th post operative day

after removal of indwelling catheter and abdominal drain. DJ stent was removed after 6 weeks. Patient was followed up after 1 week, 3 monthly for 1st year, 6 monthly for next 2 years and annually thereafter.

**Complex congenital Urological Anomalies:** Two cases of Right side Congenital Duplex system (1 each of complete and incomplete duplication) were managed by Laparoscopy. Port placement were 5 mm umbilical for telescope and one 5 mm working port in the midline between xiphoid and umbilicus and another 5 mm working port on the right side along mid clavicular line just below the level of umbilicus.

**Case 1 [Figure 6]:** Incomplete Y-shaped duplication: A 2½ years old boy presented with recurrent pain right flank on US, DTPA and CT Urography revealed PUJO. But we encountered an intra-operative surprise in form of incomplete duplication of Y type of anomaly. Laparoscopic assisted side to side uretero-ureterostomy was performed with anastomosis done extracorporeal (Figure). A 6 Fr DJ stent was placed. He developed severe urinary tract infection post operatively which was managed by IV antibiotics. DJ stent was removed 8 weeks post operatively. Patient was followed up on week 1, 3 monthly for 1st year and annually thereafter. Follow up visits include 3 monthly Urine routine examinations, Urine C/s and US. DTPA was done annually for 3 years.

**Case 2 [Figure 7]:** Complete duplication with non-functioning upper moiety: A 3 year old girl presented with recurrent UTI, dribbling of urine and was evaluated with Urine R/e, Urine C/s, US

abdomen, DTPA, CT Urography which revealed a duplex system with upper non-functional moiety on the right side and its ureter opening separately in the upper vagina. Patient underwent Laparoscopic excision of the non-functional upper moiety along with its ureter. Operating time was 115 minutes. Blood loss was minimal (10-15 millilitres). A 7 Fr DJ stent was placed which was removed 8 weeks post operatively. Specimen was sent for histopathologic examination. Patient was followed up on week 1, 3 monthly for 1st year and annually thereafter. Follow up visits include 3 monthly Urine routine examination (Urine R/e), Urine C/s and US. DTPA was done annually.

### Thoracic System

**Video Assisted Thoracoscopic Surgery** Five patients including 2 boys and 3 girls aged between 2 years to 13 years diagnosed as empyema thoracic (Post pneumonic) on evaluation by Blood culture, Chest X-ray, CECT chest. All patients had pre-operative tube thoracostomy done initially. Video assisted Thoracoscopic procedure was done in all cases. Initial port was placed through the previous tube thoracostomy site. Two more working ports were used as per the location of loculated collection. All adhesions were taken down; contents of the cavity sucked out and sent for culture sensitivity. Operating time ranged between 60 – 120 minutes (Mean – 90 minutes). Chest tube was kept post operatively for 3-6 days depending on the drainage. Serial chest X-rays were done post operatively to assess the lung expansion. Hospital stay ranged from 5-12 days.

**Table 1: Details of various diseases managed by Laparoscopy in Pediatric Age group**

System Involved	Procedure	No.	Age Range	Gender Male Female	Operating Time Range (Mean)	Complications	Conversions/Lap Assisted	Hospital Stay (Mean)
Hepatico-Biliary	Cholecystectomy	31	2½ yrs – 14 yrs	9 Male 22 Female	30 – 90 min (45 min)	Port site infection -1	0/0	1-3 days (1.4)
	Hepatic Hydatid cystostomy/pericystectomy	07	3 yrs - 14 yrs	3 Male 4 Female	110 -130 min	Prolonged biliary drainage -1 (Failed ERCP stenting)	0/0	3-14 days (6.2)
Abdominal wall and Diaphragm	Congenital Inguinal Hernia	55	1 yr - 10 yrs	38 Male 17 Female (u-31, b-7) (u-11, b-6)	30 –100 min (45 min)	Recurrence -3, scrotal edema – 3	0/0	1-3 days (1.16)
	Morgagni	01	12 yrs	1 Male 0 Female	120 min	Nil	0/0	6 days
	Umbilical	03	4 yrs - 7 yrs	0 Male 3 Female	50 – 90 min (75 min)	Nil	0/0	1-2 days (1.33)
Gastro-Intestinal	Appendectomy	71	3 yr - 14 yrs	30 Male 41 Female	45–110 min(65 min)	Port site infection – 1 subphrenic collection - 1	2/0	1-4 days (1.96)
	Malrotation of Gut	01	14 yrs	1 Male 0 Female	130 min	Nil	0/1	5 days
	Hirschsprung's Disease	05	5 yrs – 12 yrs	2 Male 3 Female	90-120 min (110 min)	Enterocolitis – 1	0/5	5-14 days (7.4)



								(days)
Genito-Urinary	Non-Palpable UDT	107	1 yr - 13 yrs	107 0	60-90 min (80 min)	Testicular atrophy – 2 Post operative Ascended – 3	0/0 Fowler-Stephens - 3 Orchidectomy – 2	2-4 days (2.25)
	Varicocele	08	4 yrs – 12 yrs	08 0	25-50 min (35 min)	Nil	0/0	1-2 days (1.25)
	Pyeloplasty	01	3 yrs	0 1	110 min	Nil	0/1	5 days
	Complex Urological Congenital Anomalies	02	2 ½ yrs - 3 yrs	1 1	115-140 min	UTI – 1	0/1	5-6 days (5.5)
Thoracic	Video Assisted Thoracic Surgery (VATS)	05	2 yrs - 13 yrs	3 2	60-120 min (90 min)	Nil	0/0	5-12 days (7.6)
Diagnostic	Laparoscopy	67	3 yrs - 14 yrs	16 51	60-120 min (85 min)	Adhesion obstruction - 2	3/0 Re-op - 2	2-14 days (3.8)
Total		364	1 yr - 14 yrs	219 145	30–140 min (75 min)	Minor - 06 Major – 13	5/8 Re-op - 5	1-14 days (3.83)

No. – Number; u – unilateral; b – bilateral; min – minutes; UDT – Undescended Testis; yrs – years, Re-op – Reoperation



Figure 1: showing cholecystectomy in a child in an acute setting.



Figure 2: Pericystectomy being done in a case of Hepatic Hydatid Cyst after removal of germinal membrane. Harmonic shears is a useful instrument for this step.

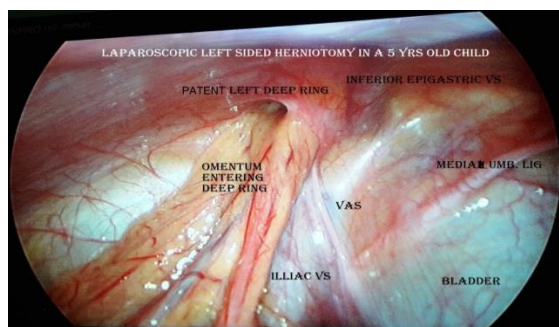


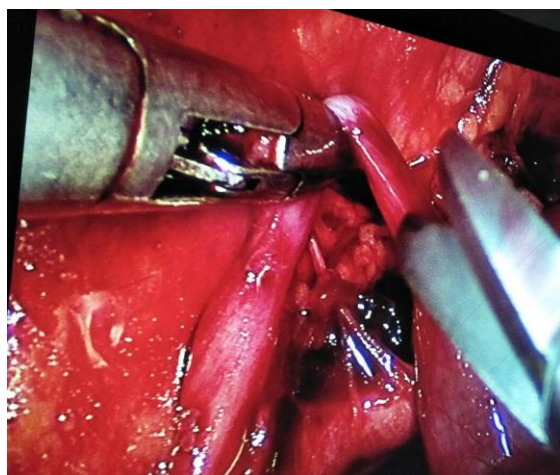
Figure 3: Intraoperative view of left sided indirect inguinal hernia (omentalocele) in a 5 years old child



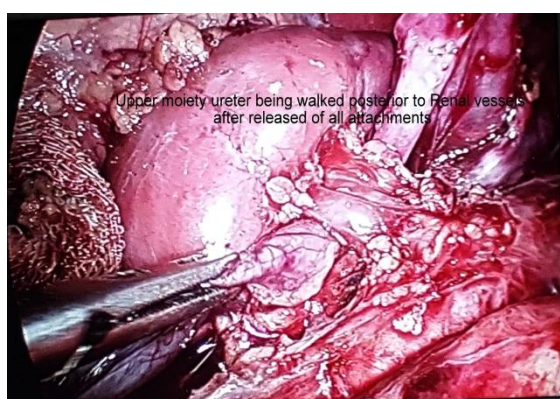
Figure 4: A rare finding of abdominal hydrocele in a 1 year old child operated for Large scrotal hydrocele



Figure 5: Intraoperative view of a child operated for Abdominal Undescended Testis. The testis in this case was at the level of lower pole of Kidney. Child underwent First stage Fowler-Stephen technique.



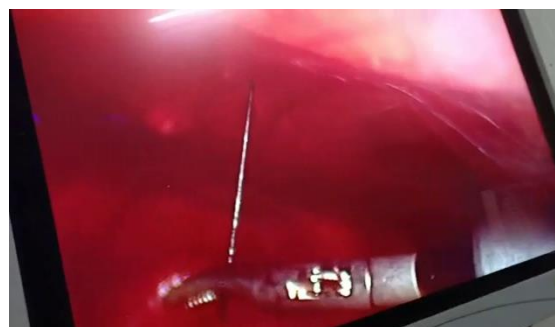
**Figure 6:** Intra-operative surprise findings of Y-type incomplete Duplication of Ureter in a 2½ years old child operated with preoperative diagnosis of Congenital PUJO. Child underwent Laparoscopic assisted ipsilateral uretero-ureterostomy.



**Figure 7:** Non-functional upper moiety ureter being walked posterior to renal vessels after release from all attachments and cut distally, in a 3 years old girl child with complete duplication of ureter. The ureter was opening into upper vagina as an ectopic opening.



**Figure 8:** Intra-operative view of a tubercular abdomen. Note the dense adhesions between parities and gut. The caseating tubercles are seen at places.



**Figure 9:** Intra-operative view of a abdominal foreign body (Knitting needle commonly used by Kashmiri girls who hold them in mouth while aligning the layers of cloths before stitching). X-ray abdomen-pelvis and CECT revealed needle. Intra-operatively C-Arm was used to locate the exact position.



**Figure 10:** Cosmetic beauty of Laparoscopy. Laparoscopic Hydatid Partial Cystectomy done in a 3½ years old girl child.

#### Diagnostic Laparoscopy

Sixty seven patients including 16 males and 51 females age ranged between 3 years – 14 years underwent diagnostic laparoscopic for repeated admissions due to non-specific vague symptoms like recurrent pain lower abdomen, sub-acute intestinal obstruction. Twenty one patients had multiple adhesions of the omentum [Figure 8]; mesentery and gut with the parities, 7 girl patients had intra-operative findings suggestive of pelvic inflammatory disease (PID), 10 patients had tubercular abdomen, 2 patients had Meckel's diverticulum, One girl had history of foreign body ingestion (2 inches long metal needle perforated through sigmoid lying in the tip of omentum [Figure 9]. In 26 patients no obvious cause of recurrent pain was found, appendectomy was performed in all such patients. A 5mm/10mm



Umbilical port was placed for telescope and after thorough surfing 2 lateral working ports were placed on both sides keeping in view the pathology found. Any collection of fluid, pus was aspirated and sent for analysis. All adhesions were taken down. We had to convert three cases because of dense adhesions. Overall operating time ranged between 60 – 120 minutes (mean 85 minutes). Biopsy of the relevant structures was taken and tissue was sent for histopathologic examination. 5 biopsies from adhesions and 1 biopsy from PID patients turned out to be tuberculosis making a total of 16 tubercular abdomens. All such patients were put on Anti-tubercular therapy and responded well to the treatment. We had to convert 3 patients due to extensive adhesions. Two patients had adhesion obstruction post operatively at 2 and 3 months and were managed by exploratory laparotomy and adhesionolysis.

## DISCUSSION

Laparoscopy in paediatric age group is gaining momentum day by day with increased pouring in of reports from many studies conducted all around the globe.<sup>[1-3]</sup> Majority of the studies conducted on paediatric laparoscopy in the last few decades have shown its safety and feasibility. With increasing awareness among the masses the acceptability of laparoscopic surgeries is also gaining momentum among the population and paediatric surgeons are now discussing option of laparoscopic intervention more freely with the parents/Guardians. We present our experience of performing laparoscopic surgeries in Paediatric age group over the last 10 years stressing upon few commonly performed procedures.

Based on the level of difficulties encountered and expertise available we divided these procedures into Simple and advanced procedures. Majority of the procedures were simple including Herniotomies, Orchidopexies, Cholecystectomies, Varicocelectomies, and Appendectomies. During the second half of our 10 years experience we started performing advanced procedures also like Laparoscopic for Hepatic Hydatid disease, VATS, Laparoscopic assisted Soaves for Hirschsprung's disease, Complex congenital urological procedures, Ladd's procedure for Malrotation of gut, and Morgagni hernia repair and Adhesiolysis. Now we have started performing these advanced procedures routinely. [Figure 10]

Earlier studies mostly used Open Hassan's technique for access but in our study the access was mostly achieved by using pediatric Veress needle. Open Hassan's technique was only used during initial 2-3 years of the study and in cases of diagnostic laparoscopy. The pressure of Pneumoperitoneum needs to be kept between 6-12 cm of H<sub>2</sub>O, flow of gas about 0.9l, ventilation to be controlled, and vitals

monitoring is very essential. Preoperative optimization, intraoperative diagnosis, treatment and monitoring along with postoperative care for observation and management of additional effects of residual carbon dioxide load is paramount.<sup>[4]</sup>

### Hepatobiliary System:

**Cholecystectomy** Considered gold standard in adults it is rapidly gaining popularity in paediatric arena. In fact we started our Laparoscopic journey in Pediatric age group by performing laparoscopic cholecystectomy. Non-haemolytic cholelithiasis is the commonest indication for cholecystectomy in children in our study which corroborated with the global scenario.<sup>[5]</sup> Laparoscopic approach offers the advantages of minimal morbidity, shorter hospital stay, earlier return to school and a better cosmetic result.<sup>[6]</sup> In our study we found parents/Guardians to be highly satisfied with small almost non visible scars post operatively.

**Hepatic Hydatid Partial pericystectomy:** Considered a zoonotic disease endemic in regions of Jammu and Kashmir some patients may present as incidental finding on radiology. Peak age of presentation in children is considered to be 5-15 years in children but we encountered patients as young as 3 years.<sup>[7]</sup> If untreated cyst can grow to enormous size and rupture. Radical excision of pericyst had reported fewer recurrences.<sup>[8]</sup> Care is to be taken to isolate the cyst from other abdominal organs by using scolicalid (10% Povidone-Iodine) soaked ribbon gauzes. After removal of cyst contents we too tried to remove pericyst as much as possible. Spillage is to be avoided at every step especially during removal of membranes through port site in either customized retrieval bags or one can use easily available sterilized drip set bags (used in our study).

### Abdominal wall and Diaphragmatic defects:

**Inguinal hernia repair** Inguinal hernia is one of the most commonly encountered conditions in children. Though considered controversial but recent studies it has shown it to be feasible, safe and reliable technique so much so that surgeons have started with novel technique of laparoscopic single instrument closure of inguinal hernia in female children.<sup>[9]</sup> Moreover it also makes it possible to detect a contralateral Patent Processus Vaginalis (PPV) which can be dealt with in the same sitting.<sup>[10]</sup>

**Umbilical hernia repair:** After gaining confidence we started offering laparoscopic anatomic repair of umbilical hernias in children and it yielded good results. We found it to be safe and feasible in paediatric patients.

**Morgagni hernia repair:** The defect occurs through the embryologic space of Larrey accounting for less than 2% of all diaphragmatic hernias. Often discovered incidentally barium enema or a CT scan may confirm the diagnosis. Laparoscopic and thoroscopic surgical intervention are gaining

momentum for repairing these defects for its advantages of shorter hospital stay, cosmetic and fewer complications.<sup>[11,12]</sup>

### **Gastro-Intestinal System:**

**Appendicectomy:** Endoscopic appendectomy was first described in 1983.<sup>[13]</sup> Since then it has rapidly become popular and is considered now to be safe and effective technique. Laparoscopic appendectomy though considered debatable by some while comparing it to open methods has definite advantages in terms of cosmetics, less morbidity, shorter hospital stay and finding an additional pathology especially in females.<sup>[14,15]</sup> During our initial experience we had to convert 2 patients because of extensive adhesions but as we gained experience adhesiolysis was achieved laparoscopically in other patients. Patients should be watched post-operatively for any collection and should be managed by IV antibiotics and if significant collection is revealed on US might require drainage by radiologic guidance (Aspiration/Pig-tail catheter)

**Hirschsprung's disease:** Hirschsprung's disease is a debilitating condition and managing such children has always been challenging. Soave described an endorectal approach in 1964. Georgeson et al described laparoscopic assisted mobilization of the aganglionic colon, along with trans-anal dissection of mucosa and submucosa.<sup>[16]</sup> The drawback with Soave procedure is its high propensity for constipation post operatively but is manageable. Enterocolitis post procedure especially in patients having it pre-operatively is worrisome as it can be life threatening and should be managed with IV antibiotics, rectal washouts.<sup>[17]</sup>

**Malrotation of Gut:** Though Ladd's procedure by open method has been the gold standard technique for Malrotation of gut but with increasing experience in working in small abdominal cavities of children had led the pediatric surgeons to persistently venture into minimal invasive procedure for this entity with favourable results.<sup>[18,19]</sup>

### **Genito-Urinary System:**

**Orchidopexy:** Laparoscopy has rapidly been adopted as the surgical intervention of choice in paediatric patients with NPUDT as it has been seen to be a safe procedure and also a reliable diagnostic tool for localization of Abdominal UDT with absolute accuracy.<sup>[20,21]</sup> Always look for the patency of the deep inguinal rings and course of the vas. Since majority of retroperitoneal dissection is done under vision it is most suitable for pop out testis too and highly beneficial for atrophied /vanishing testis not localized on radiology. Testis as high as near the lower pole of kidney can be brought down into scrotum as a double staged laparoscopic procedure.<sup>[22]</sup>

**Varicocelelectomy:** Advances in paediatric laparoscopy has made management for varicocele a viable option which can be offered to the parents of affected children as it is gaining acceptability in the recent past.<sup>[23]</sup> Deviating from the conventional methods of taking down whole of the testicular vascular bundle including artery we preferred to ligate and cut only testicular veins 1-2 cm away from the ring taking care not to disrupt lymphatic tissue by isolating the vein by gentle meticulous dissection. Some authors stressed that leaving testicular artery out of ligation may lead to recurrence but in our limited experience we did not have any recurrences but need larger number of cases to conclude.<sup>[24]</sup>

**Complex congenital Urological anomalies:** Abdomen is a Pandora's Box and retroperitoneal area is no exception. In incomplete duplication of Y-type uretero-ureterostomy is a viable option as it allows minimal dissection and ease of procedure. Since our experience for paediatric intracorporeal suturing was limited at that time we preferred extra-corporeal anastomosis by making a 2 centimetres incision in the flank.<sup>[25]</sup> Partial nephro-urectomy is advocated for symptomatic non functioning renal moiety taking ureter as much as possible within the resected specimen.<sup>[26]</sup>

**Congenital PUJO:** Well established in adults laparoscopic pyeloplasty can be performed safely in children with good results.<sup>[27]</sup> It is sometimes technically challenging especially in redo-surgery post open Pyeloplasty and patients with intra-renal pelvis.<sup>[28]</sup>

### **Thorax:**

**Video Assisted Thoracic Surgery (VATS):** Earlier it was thought that open thoracostomy is the only approach available to tackle cases of empyema by decortications /debridement necessitating prolonged hospital stay and morbidity.<sup>[29]</sup> This has been largely overcome by way of VATS. Much experience has been gained over the years to opt VATS for various other thoracic lesions like Biopsies, Pulmonary Hydatid, Tracheo-esophageal fistula.<sup>[30]</sup>

### **Diagnostic Laparoscopy:**

Whenever in diagnostic dilemma, the way out is to put in the telescope and see. This holds true for many symptoms without obvious diagnosis in spite of huge armamentarium of investigations available at surgeon's disposal. Majority patients had history of recurrent pain abdomen for varying durations and had repeated admissions and frequent investigations. Thorough and careful abdominal surfing is paramount to ascertain the cause of symptomatology. If found should be dealt with appropriate procedure laparoscopically if expertise is available. Adhesiolysis should be very meticulous and gentle. It was peculiar to see the improvement in symptomatology in patients without any obvious intra-operative finding after appendectomy.



## CONCLUSION

Laparoscopy in pediatric age group is safe, feasible and rapidly gaining popularity even for advanced procedures. Minimal Access Surgery has already made its mark in the pediatric surgeries. As more and more data is being generated annually more complicated surgeries including reconstructive surgeries in children are being performed around the globe so as to give maximum benefits of laparoscopy. However the threshold of better judgement should be low for avoiding unnecessary morbidity in small children.

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